

ATTACHMENT 1.4

Assumptions And Bases for Worker And Public Dose Assessments

Prepared for Black Range Minerals, Nucla, Co.

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Assumptions and Bases for the Worker and Public Dose Assessments

This attachment is provided to respond to the Colorado Department of Public Health and Environment 's (CDPHE) letter to Black Range Minerals of 13 August 2016 in which CDPHE requested that Black Range Minerals provide:

A description of the assumptions used for the above estimation (ed. note: of worker and public doses) and evaluation and their bases. The assumptions should be made based on the anticipated commercial-scale AMT operation and the anticipated uranium (and its progeny) contents in the pre- and post-AMT materials.

The following assumptions were used in the assessments of worker and public doses presented in Attachments 1.1 and 1.2:

1. Ore grade assumed to be 0.25% input and 1-2% output from the ablation process; ore grade in the post ablation waste rock returned to the mine assumed to be 0.01%
2. Raw ore mined in a conventional way and delivered to the Ablation room. The potential exposures resulting from the conventional mining that occurs prior to application of AMT is not included in the analysis of exposures that are directly associated with this application of AMT in the Sunday mine. The workers operating the ablation process are not the same individuals who are the conventional miners.
3. The design concepts presented herein should be considered as preliminary. Further details and specifics of design will be developed in response to yet to be defined requirements of other regulatory agencies. These include, e.g., required revisions to the DMRS mine permit, requirements to address BLM's NEPA responsibilities, etc. Note that DMRS has indicated they will not define their revised permit requirements until CDPHE makes a determination on AMT.
4. Radionuclide secular equilibrium is maintained throughout the AMT process: (1) maximizes the source terms throughout process and the associated exposure rates and (2) "Waste rock" has minimal progeny consistent with the equilibrium concentrations associated with the very low grade of the residual U (0.01%) and is therefore not radiologically the same as 11.e (2) byproduct material. The activity ratios of uranium to its progeny (degree of equilibrium) is not altered by the AMT process, and the full equilibrium condition remains as it occurs in nature in both the ablated slurry product and the low level, resultant concentrations of uranium and progeny in the "waste rock" that is returned to the mine. These assumptions are corroborated by the laboratory data provided in Attachment 3.0.
5. The application of AMT is primarily an aqueous process and therefore no significant dusts are generated once the ore is fed to and crushed in an enclosed unit and then continuous in an aqueous phase throughout which also minimizes radon evolution.
6. Three workers spend 60% of their collective time in the Ablation room; remainder of time on the surface and/or performing work in areas that do not involve occupational exposure associated with the AMT process.
7. Equipment and component specifications are as defined in Table 1 of the Worker Exposure Report



8. External photon exposure rates from each of these 13 “sources” were summed for each of 24 receptor locations via Microshield (Grove Software 2014) with an uncertainty analysis performed via MCNP (Los Alamos National Laboratory 2011). A 30% reduction factor was applied to the Microshield results since the MCNP analysis indicated that the Microshield results included up to a 40% or more overestimate of exposure rates in some cases.
9. Exposure rate in was air converted to absorbed dose in tissue via methods in Cember and Johnson 2009.
10. Worker exposure during operations will be monitored and controlled via conventional and traditional health physics programs for U recovery facilities (e.g., ANSI 1973, USDOE 2009, USNRC 1992, IAEA 2004).
11. Given the extensive historical database from Health Canada (> 1400 total miners and millers / year in each of last five years) and the historical Cotter mill data (2005), the MSHA underground uranium miner exposure data for the last 5-10 years that has been requested through the FOIA is not critical. It is assumed that no more than about 100 (or less U miners) / year would be associated with this database. Similarly, in the case of the White Mesa mill data which Energy Fuels will not provide, only a dozen or two mill workers / year would be in this data base.
12. Given the much larger worker populations and higher ore grades in Canada, the Canadian exposure data is considered of primary importance in these comparisons and have been used relative to exposures of similar job categories in US underground uranium mines and mills.
13. Since the previous estimates of public exposure performed by the former operator of the Sunday mine as documented in annual USEPA 40 CFR 61 compliance reports (Dennison Mines 2009, 2010, 2011) demonstrated exposures well within the 10 mrem / yr. EPA limit (nearest residence = 4+ miles), it is reasonable to assume confidence in compliance today, particularly given the aqueous process which would result in less generation of particulate dusts and a small additional contribution to the radon mine’s source term.
14. The ablated product which is sent to a conventional uranium mill will be in slurry form (anticipated about 25 % water content) that can be directly fed to the mill with a minimum of labor involved. Accordingly, no traditional “ore handlers” will be required to move and feed ore rock into the mill’s front end crushing and sizing circuits. This is expected to eliminate individual worker exposures of 2 – 3 mSv / year (several hundred mrem / year) that is traditionally associated with ore handling. Under the assumption that a large (1000 -1500 tons / day ore feed) mill would employ 5 – 10 full time ore handlers, the use of ablation mining could save 15 - 20 mSv + (several thousand mrem) collective dose per year at the mill.
15. It is recognized that other permits and related authorizations will be required from other agencies to proceed with this project, e.g., revision of the existing DMRS permit to mine, BLM Plan of Operations and associated NEPA requirements, etc.



REFERENCES

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